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THE CHINCH BUG.

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BULLETIN

OF THE

Ohio Agricultural Experiment Station.

NUMBER 69. March, 1896.

THE CHINCH BUG. *Blissus leucopterus* Say.

BY F. M. WEBSTER.

EARLY HISTORY AND DISTRIBUTION.

That anything new could be said of an insect so old and well known as *Blissus leucopterus*, the common Chinch Bug, would appear almost incredible, for it probably has been more often discussed than any other of our insect fauna, in our entomological publications, especially such as deal with Entomology as one of the agricultural sciences, and by entomologists whose names will forever be connected with the science of entomology in this country. An examination of the literature of this species, however, will show that much of it is, to a great extent a repetition of the older writers; and we seem to have been going on in this way, without stopping to ask ourselves whether or not these older writers were strictly correct, and whether their statements would stand the test of modern, severe scrutiny.

The old and commonly accepted theory, in regard to the original habitat and later diffusion of this species, is that it originally occupied the country along the Atlantic, throughout Virginia and the Carolinas, from whence it spread westward in the wake of grain growing. The theory is based upon the fact that it is from these localities that reports first came of its ravages in cultivated fields; and it was described by Thomas Say while residing at New Harmony, Indiana, from a specimen from east Virginia and therefore, it is supposed, must have afterwards spread westward and northward.

Now, while I am free to say that this theory may be the correct one, we have really no proof whatever to sustain it, while we do know that over its entire habitat, in North America at least, it is fully capable of sustaining itself on both wild and cultivated grasses, and that its occurrence does not depend upon the extent to which the country is devoted

to grain growing. I have found it in the alluvial portions of Louisiana, where very little corn is grown, far more abundant than in Northern Indiana, where the area devoted to grain growing is vastly more extensive, while in the latter region it was not one per cent. as numerous as in portions of Illinois where the area cultivated in grains was no more extensive; all of the localities being topographically much alike in character. In 1894, the late Dr. J. C. Neal, of Stillwater, Oklahoma, wrote me that he had found these bugs in that Territory, miles from human habitation, in immense numbers and at the roots of the native grasses. In 1854, Dr. Fitch found them in autumn, in Northern Illinois, amidst extensive prairies, where, on parting the grass, the ground was covered and swarming with them.[1] The outbreak in New York, in 1882 and 1883,[2] was not in the grain fields but in timothy meadows. In 1884, Mr. W. H. Harrington, took it abundantly along the sea shore, at Sydney, Cape Breton, clustered on bunches of grass.[3] Prof. Otto Lugger found them destroying timothy near the shores of Vermillion Lake, in Northern Minnesota, where the only agricultural product beside was potatoes.[4] In his short paper in Insect Life, Vol. VII, pp. 232–34, 1894, Mr. C. L. Marlatt, calls attention to the fact that in Kansas he found these insects hibernating in great numbers in the dense stools of some of the native grasses. So marked was this hibernating habit that Mr. Marlatt questioned if this was not the "normal and ancient habit of the species, the natural food-plant of which, before the advent of the white man and the growth of cereals, must have been some of the native grasses." In commenting upon Mr. Marlatt's note, in Insect Life, Vol. VII, p. 420, Mr. E. A. Schwarz states that "the same habit of clustering about the roots of tufts of grass is at present to be observed along the Atlantic coast from Cape Florida to Atlantic City, New Jersey," and adds that "the unique appearance of the fullgrown chinch bug, with its white wings and chalky white pubescence, forcibly indicates that the insect is either a psammophilus or maritime species"; and further expresses the opinion that its geographical distribution fully bears out the theory of its belonging to the latter class.

It will be observed that this habit of clustering about the tufts of grass along the sea shore is borne out by Mr. Harrington's observations, much farther northward. It appears to me that Mr. Schwarz, in his statement that the species is probably a maritime one, has given us the key to the whole problem, and I shall discuss this factor, at length, farther on, and will only here suggest that it is sub-maritime instead of

[1] Fitch, Second Report Insects of New York, p. 283.
[2] Lintner, Second Report, State Entomologist, N. Y. p. 159.
[3] Canadian Entomologist, Vol. XXVI, p. 218.
[4] Bull. 37, University of Minn., 1895.

maritime, and also add to the mass of proof here presented, going to show that the species is capable of sustaining itself on grasses, by calling attention to the fact that during the recent outbreak in Ohio, almost without exception, all of the complaints of ravages in the northeastern part of the State were of injuries to grass.[5] It seems to me that we now have before us ample proof that this insect may not only exist, but become abundant, perfectly independent of cultivated grains.

The question of a westward advance of the species from the Atlantic coast, is however, a valid one and must be carefully considered. Fitch, states in his second report, p. 278, that the insect first began to prove destructive in North Carolina in 1783. Webster, in his work on Pestilence, Vol. I, p. 279, states that in 1785, fields of wheat in North Carolina were so overrun with these insects as to threaten total destruction to the grain. Now, if I mistake not, North Carolina had, at this time, become about as thickly populated, and agriculture had advanced to about the same magnitude, that it had in the west when the species first began to attract attention in 1823 in Southern Illinois, 1850 in Northern Illinois, 1855 in some portions of Iowa, and in Kansas, Nebraska and Minnesota later on. That is, these insects began to attack cultivated plants over the whole area of their present habitat where they have been destructive, at about the same period of agricultural development, and density of rural population. The trend of these has been westward, but the fact does not prove the non occurrence of *Blissus leucopterus* in considerable numbers, prior to the advance of this wave of civilization and agricultural progress. The only data upon which the assumption that the two phenomena were coexistant, is so far as I am aware, based on the fact that the species was described by Thomas Say in 1831, while a resident of New Harmony, Indiana, the description being drawn up from a specimen from the eastern shore of Virginia, while he at no time mentioned its occurrence elsewhere. Prof. S. A. Forbes, in the Sixteenth Report of State Entomologist of Illinois, p. 50, presents conclusive evidence of the occurrence of this species as early as 1823, in Southeastern Illinois, and within twenty-five miles of New Harmony, Indiana. Say was a very busy man and might or might not have known of this occurrence.

Thus the only data upon which to base the assumption that the chinch bug moved westward with the advance of agriculture is swept away, and we are forced into the conclusion that it would have been able

[5] C. L. W. writing to the *Farmer's Review*, and whose communication was published in the issue of that paper for November 2, 1887, stated that he had been farming in Smith county, Kansas, ever since it was first settled, and the first crop of corn that he raised there was planted on sod, and was covered with chinch bugs, though there was no grain to speak of within one hundred miles of the field.

to sustain itself on the native flora, and that there is nothing to prove that it did not do so. The fact of its attacking cultivated plants, later on in the progress of agricultural development, does not by any means necessarily imply a recent introduction. All or nearly all native insects adapt themselves to cultivated plants only when forced to do so by the encroachments of the latter upon their natural food plants, and I think we can show that *B. issus leucopterus* is not an exception. Fitch, Marlatt and Neal, have all observed the species hibernating among the native grasses, or else found them in late fall or early spring in situations that indicated that they had done or were about to do so, and in the case of Dr. Neal, this was observed at a long distance from human habitation.

The aborigines, we know, were in the habit of burning over the prairies and other grass producing areas, in the fall of the year, which must necessarily have destroyed vast myriads of these insects after the season of hibernation had begun. With the retreat of the Indian came a decline in prairie fires, and the early settler, beginning where the Indian left off, burned over the uncultivated areas in the fall to protect his buildings, or the dried grass was fired by sparks from locomotive engines passing over widely separated lines of railway. But gradually these tracts of native grass lands would become so interspersed with cultivated fields that prairie fires, as we have always termed them, no longer occurred.

In his second report, already referred to, Dr. Fitch states that about Sandwich, Illinois, the insect began its ravages in wheat fields in 1850. This was ten years after the Pottawattamie Chief, Shabbona, and his tribe abandoned the country, and two years before my father settled in that immediate locality, and I know from personal experience that there was then only a limited cultivation of grains, and a decline in the burning over of the grass lands in the fall was followed by rapid increase in the abundance of this species, and in a locality where all available information points to its having been able to sustain itself and increase in numbers while subsisting upon the native grasses. I feel that I am justified in supposing that a similar condition would result in a corresponding increase elsewhere.[6]

We will now turn to Mr. Marlatt's suggestion that the clustering about the roots of tufts of grass is the normal and ancient habit of hibernation. But I shall go farther and add also the gregarious habits of the larvæ and pupæ. Dr. Fitch witnessed this mode of hibernation in Illinois, in 1854, while Dr. Neal observed the same phenomenon in Oklahoma, in 1894, forty years later, so that we have absolute proof that the habit has been followed at several widely separated, inland points, for

[6] Professor Lugger writes me that the insect does not occur in his State on the prairies, but in the timbered portions, excepting such as are covered by pines.

nearly have a century; and Mr. Schwarz has shown that this habit at present prevails along the sea coast, from 1,000 to 1,500 miles distant. Along the coast, where the grass grows in tufts, it is absolutely necessary for these insects to congregate together in masses, but in the Mississippi Basin, or at least over the greater portion of it, the grasses are much more evenly distributed, yet we find the habit as closely adhered to as elsewhere, except it be in patches of closely matted blue grass.

Probably no one, however unobserving, has failed to notice the persistency with which the larvæ and pupæ adhere to their gregarious habits. That the very young should be found in numbers about a clump of grass or grain plants is not surprising, as a large number of eggs deposited in such places would account for their numbers, but after crossing a roadway or plowed field and reaching evenly distributed plants on the opposite side, they do not spread themselves out over any considerable territory, but even when their numbers are limited, they will congregate on a few plants or tufts of plants, precisely as if they had, somewhere, been obliged to follow this habit, during a long period of time, as a necessary precaution against extermination. That this characteristic habit should be continued throughout a period of fifty or even one hundred years, in a locality where such was not only unnecessary, but even detrimental, is not at all improbable, so long as it does not threaten the extermination of the species.

Although Dr. Packard has found the chinch bug on the summit of Mount Washington, New Hampshire, at an elevation of 6,300 feet, and Prof. Gillette writes me of its occurrence, rarely, near Fort Collins, Colorado, at an altitude of 5,500 to 6,000 feet, inside the foothills, Prof. Cockerell who collected carefully in Colorado for several years, about West Cliff, Custer county, at an approximate elevation of 7,000 to 8,000 feet did not find it at all. It is reported from Volcan de Chiriqui, Panama, at an elevation of 6,000 feet. (Biologia Centrali-Americana, Vol. I, p. 196.). How common Dr. Packard found it on Mount Washington, I do not know; but as Mrs. Slosson has collected very carefully on the mountain at various times, without securing it at all, I infer that it occurs there but rarely, and as Packard's date was August, in the midst of the mid-summer migrating season, we may in North America, safely look upon its occurrence at that time as due to its nomadic habits. Prof. Gillette, as he writes me, has found but three or four specimens, also probably stray individuals. How abundant it was found on the volcano in Panama, I have no means of learning, but I believe we can safely say that its occurrence in high altitudes is due to its somewhat roving habits, especially at the periods of migration, which, while it strengthens the idea that the insect might have crossed the Alleghany Mountains at an early day, to precisely the same

or even a greater extent does it strengthen the theory of an early spread over a much more level country, from the south.

Therefore, we may safely say that its normal habitat is an altitude of from a few to 1,000 or possibly 1,200 feet above sea level. It is a plain loving species and, according to my own experience, running over some forty years, it prefers a clay to a sandy soil. I believe with Mr. Schwarz that it is not a psammophilous but a maritime species, (or semi-maritime, as I would put it) not a sand-loving but a coast loving insect. It certainly does not especially favor the near vicinity of the shores of the great lakes, and I have never found it in close proximity to any of these except in limited numbers.

The outbreak in New York, previously mentioned, is the only instance on record where it has occurred in abundance close to any of the great lakes, and this case hardly constituted an exception, as the outbreak was more especially along the St. Lawrence river, and some thirty or forty miles from the eastern shore of Lake Ontario. To offset this, over the lower peninsula of Michigan and in Northern Indiana, between Lake Erie and Lake Huron on the east, and Lake Michigan on the west, the country is almost uninhabitated by the species, it being impossible to find, after continued search in favorable localities, more than an occasional specimen, and I believe this to be true also of Ontario, Canada, north of Lake Erie, even at a time when from western Indiana, westward to beyond the Mississippi river, they were proving a veritable scourge. See Map, Fig. 1. Hence while it is a sea-loving, it cannot be said to be lake-loving, clearly preferring salt to fresh water. I have stated that it is a plain inhabiting insect, but it may inhabit very limited, flat areas, interspersed among more broken and elevated areas.

As illustrating this habit in Ohio, I may state that in 1894, I found it quite abundant in Champaign, Logan and Hardin counties, with its greatest abundance in the latter and Wyandot county to the northeast, the two latter being of a more level topography than the two former. In 1895, the area of greatest abundance included only Wyandot and a portion of Hardin counties, Champaign suffering little, while to the south in Greene and Clarke counties, where, in 1894, I had found it sparingly, it did not occur in abundance at all, thus showing that it had drifted to the lower and flatter lands to the east, except in Wyandot and a portion of Hardin, where these conditions already obtained, and overrun a wide range of practically flat country having a clay soil. See Map, Fig. 2. A portion of the State lying to the west and northwest of Lake Erie, being the ancient bed of the preglacial lake, and the soil sandy instead of clayey, was little if at all infested, whereas, the flat, clay lands, to the south and west were in some localities literally overrun with these insects.

Now, while the species appears to inhabit low, flat lands, by preference there is one phenomenon that is seldom mentioned by those writing or speaking of its habits, and that is the quite general preference shown by the females in selecting any slight elevations in the fields, such as hummocks or even what are known in agricultural parlance as "back-furrows," where two furrows are thrown together forming a slight ridge, as places for ovipositing; and I have noticed in large fields of comparatively low, flat land, that the wheat on these slight elevations would turn white and die from attack while the lowest portions would remain uninjured, precisely as if the females had expected to avoid all probability of their progeny being submerged by a sudden, excessive rainfall, tides, or unusually high waves, such as would be likely to occur in a tropical country or along the seashore. It seems to me that we may here have another illustration of an ancient habit, followed formerly throughout a long period of time, through necessity, and now by inherited instinct.

Mr. Schwarz has cited the extreme susceptibility of *Blissus leucopterus* to the influences of moist weather, as being in striking contrast with the behavior of other insects which are native to the states inhabited by it in North America, and thinks that this, with the fact that it seems almost wholly free from parasites, points strongly to its being an immigrant from some other more or less distant habitat. I would not only coincide in this opinion, but beg to add three other, so far as I can see, equally strong points: Lack of variation from the type would indicate a strict adherence to old established habits, or a short residence in North America, while the frequent occurrence of adults with aborted wings would imply that it had sometime lived where either the wings were useless or else where their use would render the possessor liable to be blown out to sea. It is easy to see that a species as migratory as the chinch bug, if inhabiting a narrow tract of land swept by cross winds, would have need of such a protection and in fact Mr. Schwarz finds it apterous along the east coast of Florida, so that we here have an occasionally appearing character that may, inland, be the remnant of an ancient condition. That *Blissus leucopterus* is only very slightly variable is quite in harmony with the idea of a northern spread, the whole group, *Blissina*, its nearest relatives, every one of them being found in Mexico.

Mr. Schwarz, in his note previously referred to, calls attention to the marked susceptibility of the species to moist weather, as in decided contrast with other species occurring in the same region. This, it seems to me needs further explanation. It is quite probable that the effect of moist weather on the adults has been over estimated, and besides moist weather inland is one thing, while the same degree of moisture along the sea coast, where the air and soil are strongly impregnated with salt, is quite another.

Besides, a few drenching rains during the hatching season will destroy more young than almost any amount of rain will destroy of adults. I believe the adult is, directly, little if at all affected by moist weather, even away from the sea shore. That it is destroyed in myriads by the fungus, *Sporotrichrum g obuliferum*, is certainly true, but I believe this will be found more owing to the gregarious habits of the insect, both while young and when fully developed and in its hibernaculum, than to any peculiar weakness or susceptibility. There is scarcely room to doubt that the salt in the sea air and in the soil along the coast would have a tendency to counteract the effects of this fungus, though it is nowhere likely to do more than reduce an over abundance.

I have but one more point to make in this connection, and this is a philological one. The common name of this insect, chinch bug, is, we are told by Fitch, a Spanish name, given the species because of the resemblance of the young larvæ to the young of the Bed bug, *Cimex lectularius*, and the disagreeable odor of the two have, also, a strong resemblance. In the southern portion of the country, the latter species is, even at present, known to the people in general as chinch bugs. It is, perhaps, worth while to call attention to the curious fact that *Blissus leucopterus* is at present an inhabitant of Cuba, Mexico and Central America, southward at least to Panama, and also of Florida, which was under Spanish rule until long after the name chinch bug was applied to this species; a region in which with the exception of Florida, the Spanish language has always been and is yet the one in common use, except among the aborigines. While it will be too much to say that the insect was first christened by a Spaniard, we are in as much of a dilemma, when we attempt to determine just where and how far south this name "chinche," was first applied to it.

If ancient habits and environment have left their marks on the modern characteristics of this species, and I have translated these vestiges aright, we should as Mr. Schwarz has previously stated, "look for the true home of the chinch bug near the sea shore," congregating on tufts of grass, both in its early stages and as hibernating adults, where the land is under 1,000 feet elevation, and usually but a few feet above high tide, on an island, peninsula or isthmus, and north of the equator. The soil may be either sand or clay and the surface comparatively level, in occasional areas if not in general, and where the winds will have full play; and we would expect to meet here other species more or less closely allied to it, and we might further expect it to be able to survive for an unusual length of time in sea water.

We know of its occurrence in Panama, across which the trade winds blow unobstructed, the elevation being in some places less than 2,000 feet, so that it might here become distributed along both the eastern and

western coasts and work along both to the northward. Along the west coast it has been reported from Panama, not far from the border of Costa Rica, Guatemala, Lower California and California along the coast near San Francisco and in the Sacremento valley.

On the Atlantic and Gulf coasts it has been reported from Panama, Tabasco and Mexico at Orizaba and in the State of Tamaulipas, which is located on the coast near the mouth of the Rio Grande. Along the Atlantic it is known from Florida to Cape Breton. See folding map. It seems to me that a much more reasonable theory would be to suppose that the species originated either in Panama or in either the valley of the Atrato or the Magdalena rivers, of the United States of Columbia or perhaps along the Venezuelan coast in South America (and it is here that I fully expect a much closer ally than now known to be discovered) and that it has simply followed the moderately low lands, which would of necessity be located in rather close proximity to the coast, until it reached eastern Texas and Louisiana, where it not only continued to work its way eastward on account of its maritime nature, but also pushed its way northward under the inducements offered by a moderately level, slightly elevated country, producing a grass flora upon which it could readily sustain itself, thus giving it a northern and eastern, but at no time a western spread. The very narrow limit of the land in Panama would compel the insect to confine itself rather closely to the seashore, but a little farther north it seems in a slight degree to break away from the immediate coast, and inhabit the low-lands adjacent, so that it would even this near its native home appear to have become a semi-maritime species, just as I would designate it at present, and which would account for its distribution and habits as we now find them. Anyone who is familiar with the nature of the country in eastern Texas and Louisiana, and understands this plain-loving character of the chinch bug will appreciate the temptation that would here present itself for the insect to follow the level country inland, as well as among the coast.

We have observed how the southern extremity of the Rocky Mountain system divided the current of the northward stream of this insect, owing to its dislike for high elevations, and we now have a second division, not influenced by mountain ranges, but by a fondness for comparatively low and flat areas, not necessarily devoid of trees but furnishing a supply of grass plants sufficient to afford food, which, though not of the exact species found along the coast, yet more abundant and equally suitable for the purposes required by the insects. Thus, I would account for the spread of this species over the country from the south instead of the east, as we have long held to be the case, and it seems to me that all its characteristics point to Central America or the extreme northern portion

of South America as its original home. It may not be out of place to here call attention to the possibility of some individuals being carried into Caribbean Sea or the Gulf of Mexico, and through the influence of the Gulf Stream be transported to either Cuba or Florida—a possibility, but not a probability, especially as regarding Florida.

DESCRIPTION OF THE SPECIES AND LIFE HISTORY.

Adult.—Length three-twentieths of an inch. Body black, clothed with a fine grayish down not distinctly visible to the naked eye; basal joint of antennæ honey-yellow, second joint the same, tipped with black, third and fourth joints black; beak brown; wings and wing-cases white; the latter are black at their insertion, and have near the middle two short, irregular black lines, and a conspicuous black marginal spot; legs dark honey-yellow, terminal joint of the feet and the claws black.[7] Plate I, Fig. 1.

Egg.—Average length .03 inch, elongate-oval, the diameter scarcely one-fifth the length. The top squarely docked and surmounted with four small, rounded tubercles near the centre. Color, when newly laid, pale or whitish and translucent, acquiring with age the amber color, and finally showing the red parts of the embryo, and especially the eyes toward the tubercled end. The size increases somewhat after deposition, and will sometimes reach near .04 inch in length. Plate I, Fig. 2, *a* and *b*.

Larval stages.—The newly hatched young, Plate I, Fig. 2, *c*, is pale yellow, with simply an orange stain on the middle of the three larger abdominal joints. The form scarcely differs from that of the mature bug, being but slightly more elongate; but the tarsi (feet) have but two joints, Fig. 2, *d*, and the head is relatively broader and rounder, while the joints of the body are sub-equal, the prothoracic joint being but slightly longer than any of the rest. The red color soon prevades the whole body, except the first two abdominal joints, which remain yellowish, and the members, which remain pale. After the first moult, Fig. 2, *e*, the red is quite vermillion, contrasting strongly with the pale band across the middle of the body, the prothoracic joint (first behind the head) is relatively longer, and the metathoracic joint (third behind the head) shorter. The head and prothorax are dusky and coriaceous and two broad marks on the mesothorax (second joint from the head), two smaller ones on the metathorax, two on the fourth and fifth abdominal sutures, and one at the tip of the abdomen are generally visible, but sometimes obsolete; the third and fourth joints of the antennæ are dusky, but the legs are pale. After the second moult, Fig. 2, *f*, the head and thorax are quite dusky and the abdomen duller red, but the pale transverse band is still distinct; the wing-pads become apparent, the members are more dusky, there is a dark red shade on the fourth and fifth abdominal joints, and ventrally a distinct circular dusky spot covering the last three joints.

Pupa.—In the pupa all the coriaceous parts are brown-black, the wing-pads extend almost across the two pale abdominal joints, which are now more dingy, while the general color of the abdomen is dingy gray; the body above is slightly pubescent, the members are colored as in the mature bug, the three jointed tarsus (foot) is foreshadowed, and the dark horny spots at the tip of the abdomen, both above and below, are larger.[8]

There are two broods of the chinch bug each year, and it passes the winter in the adult state. I have, however, occasionally found a pupa so late in the fall as to indicate that an occasional one of these may also winter over, as far north at least as lat. 40°. The time of coming forth

[7] LeBaron, in Prairie Farmer, September, 1850.

[8] Riley's Seventh Report on the Insects of Missouri.

in spring is, of course due to the season and latitude. In extreme southern Ohio, they may appear in March or early April, while in the extreme northern portion it may possibly be late in May before they are observed.

Immediately after coming from their winter quarters in spring they pair, and the females commence to lay their eggs. Each one is thought to be capable of laying about five hundred, not all at one time, but scattering them over a period of nearly three weeks I should expect that in southern Ohio eggs might be deposited in considerable numbers during April, while I found adults and newly hatched young, together, about wheat plants in the fields in considerable numbers, near Jefferson, Ashtabula county, June 16, 1893. From the fact that there were usually but two or three old bugs about a clump or stool of wheat plants, I inferred that these were the progenitors of the young found with them, as no pupæ or well advanced larvæ were observed.

On leaving their winter quarters, the bugs either crawl to the fields of grain or grass in which they are to lay their eggs, or else take wing and scatter out over the country. I have often found them by twos about the young corn plants in May. Very rarely, according to Prof. Forbes,[9] do these old bugs concentrate in a locality in sufficient numbers to work any perceivable injury, and it is not until the young are, for the most part, well advanced in the larval, and many advanced to the pupal stage, (that is, while they are of a red, brown-black or dingy gray color), that they begin to make their influence felt in the cultivated grains of the farmer.

Occasionally, I have noticed the old bugs so thick about clumps of barnyard grass, *Panicum crus-galli*, as to cause it to wither and turn brown. As a rule, the principal injury to crops is caused by the larvæ and pupæ, or before the insect has come into possession of wings. The time required for development from the egg to the adult is probably not far from two months, and probably few if any of the hibernating individuals are to be found in Ohio, after the latter part of July, while their places have been supplied by the first brood. Early in August the second brood of young appears in southern Ohio, and I found them destructively abundant in corn fields in Gallia county on the 20th of this month.

It is not common for these insects to work serious injury except in case of the first brood and before mid-summer, but last year was so exceedingly dry, and the hay crop so nearly a failure, that many farmers sowed quite extensive areas of millet and Hungarian grass, and this the second brood took possession of in some localities and literally destroyed it. From the northeastern part of the state I also received complaints of injury to meadows by the second brood of young, but I did not see these meadows, myself, and cannot speak of them from personal observation.

[9] 15th Report, State Entomologist of Illinois, p. 93.

Generally speaking, it may be said that the ravages of this insect are committed by the first brood of larvæ and pupæ. The eggs are deposited about the bases of the plants, sometimes even below the immediate surface.

HIBERNATION.

The fully matured insects pass the winter, preferably, in dry quarters among leaves, rubbish or matted grass, though, as previously stated, the older habit was to seek winter homes about the roots of native grasses. I was considerably surprised at the apparently limited numbers that could be found in thickly matted blue grass, and had about concluded that the opinion that such places formed an important factor in the history of the insect was wrong, but on laying boards down on such grassy places in early spring, as one would do if trapping beetles, I was able to secure a sufficient number to indicate that very many may hibernate in this way without being detected by even careful search. I have learned from farmers in extreme southern Ohio, that the chinch bug is wintering there in the shocks of corn fodder, standing in the fields. A writer in the *Farmer's Review*, several years ago stated that he had observed a shock of fodder that had fallen into a ditch, and remained there long enough for a sheet of ice to form over it. After a few days the water subsided and in pulling the stalks of corn out in order to husk them, he had found quite a number of chinch bugs that, though they had been immersed in the water for a week or more, yet when removed and exposed to the warm sun, began to crawl about in a most lively manner.

I do not myself believe that wet weather has very much direct effect upon fully developed chinch bugs, and I should expect nearly as many to emerge in spring in good condition, as went into winter quarters during the preceding fall, regardless of the weather during the intervening time. As before stated it is very much more likely that a few drenching rains during the hatching season will do more to destroy these insects than will any amount of rain during the remainder of the year. In other words, it is not dry weather during some portions of the year, but during the two breeding periods that has such an effect upon the increase in numbers of the pest.

A knowledge of the place and method of hibernation is of practical value as offering a means of destroying many of the mature bugs during winter by burning the grass, dead leaves and rubbish during that period, and I am rather unwilling to accept the results of ordinary searching as proof that the pest does not winter in such places in sufficient numbers to give origin to a brood the following spring that will be capable of doing very serious injury.

REGULARITY WITH WHICH OUTBREAKS OCCUR.

Generally speaking, the chinch bug has never been a seriously destructive pest in Ohio; though the outbreak of last year was probably the most important, it was not the first. With reference to recurring periods of abundance of the chinch bug, I cannot give a better illustration than to use the statements of a correspondent of the *Prairie Farmer*, writing from Kansas, and whose communication was published in the issue of that paper for August 3, 1889, as follows:

> It has just been fifty years in September next, since I saw the first chinch bugs. This was in Indiana. In 1842 I saw just what those professors speak of—dead bugs by millions—and the living ones seemed to be in great haste from some cause. In 1843 they were almost entirely closed out. In 1846 and 1847 they came again. In 1849 and 1851 they died off as before. In 1854 they were present, but 1855–6–7 closed them out. In 1859–60–61 they were again on hand. In 1862 and 1863 they died. In 1866–7 on hand. In 1869 they died. In 1871 we had them locally, dying in 1872. In 1874 they were general. In 1875–6 they died. In 1879–80–81 they were quite general. In 1882–3 they died. In 1884–6–8, in places they were plenty. This year (1889) they are dying as usual.

Now, while I do not care to be responsible for the correctness of the above record, though it corresponds pretty closely to my own observations, it clearly illustrates the ups and downs, so to speak, in the abundance or scarcity of the pest throughout a long series of years. In Ohio, these fluctuations between abundance and scarcity have not been very marked, as, until 1887 and 1888, there had probably not been anything beyond very slight outbreaks over very limited areas, and these last may have been occurring for the last forty or even fifty years. During the few years that I have been in Ohio I have received information of these local outbreaks, not because the insect was recognized by farmers, but because by the aid of their description I have been able to identify it, and from what I have gathered together in this way, as well as occasional reference in the Agricultural Reports and Agricultural papers, it seems clear that though the pest is always with us, it has not worked nearly the amount of injury that it has in Illinois, though there has probably been a very slight increase or decrease, corresponding to the far more emphatic changes farther west. Whether or not future outbreaks will increase in seriousness of results, as has been the case between the outbreak in 1873, which was, so far as I can learn, restricted to Gallia and Scioto counties, the outbreak of 1887–88, which extended more or less over Defiance, Wood, Geauga, Allen, Darke, Shelby, Franklin, Fairfield, Meigs and Gallia counties, and that of 1895, it is as impossible to tell as it is to give a good reason for Ohio having escaped serious attacks, while Illinois and west have been overwhelmed. This much can, however, be relied upon, viz.: that when outbreaks do occur they will follow a series of dry seasons, and

as pointed out by Prof. Forbes, the first year of appearance will excite little suspicion, the climax being reached the third year. The trouble is that farmers do not, themselves, watch this branch of their business closely enough to see and take measures to check this slow but steady increase, and the third season catches them as ignorant of impending danger as is possible to imagine. The entomologist, unlike the farmer, cannot watch these matters every day as he goes about his work, and even if he did it would be suicide, so far as his reputation is concerned, to attempt to predict the future of the chinch bug, even a year in advance. If he were fortunate enough to make a shrewd guess and correctly fortell an invasion, he would receive vastly more credit than he was in any way entitled to, while if the rains came just in time to destroy the young bugs, the poor fellow would be ridiculed and no attention would be paid to his warnings thereafter.

NATURAL CHECKS.

Chief among the elements that hold the chinch bug within bounds during ordinary years is, as I have indicated, the meteorological conditions during the hatching seasons. Birds have little taste for the ill-odored things. The common quail, (*Colinus Virginianus*) is about the only bird that will afford the farmer any practical aid, though when pushed by hunger, the prairie chicken, red-winged blackbird, catbird, brown thrushes and the meadow-lark will partake sparingly of them. In his excellent paper on the chinch bug in the Report of the United States Commissioner of Agriculture for 1887, pp. 51–88, Mr. L. O. Howard has very properly pointed out the fact that over the area of greatest destruction by the chinch bug, its only enemy among the birds, the quail, is but partially protected, whereas it might with profit be entirely protected at least for a number of years. So far as Ohio is concerned, the bird laws and the enforcement of them are a disgraceful farce from beginning to end. If one wishes to study the food of birds, or their anatomy, he must break the laws of the State in order to do so.

If one were to shoot quail in some other state, where it was a perfectly legal act, and send them to a friend in Ohio, at a time when it was not lawful to shoot them here, the friend would run the risk of being arrested and fined. Birds are killed by thousands in Ohio every year, by anyone who can buy or borrow a gun and pay for the ammunition. The day that it becomes lawful to kill quail, everybody rushes to the fields, no matter whether the season has been favorable or disastrous to the breeding of quail, killing everything at sight, and if there are few quails, so much the worse for other birds. With the clearing off of timber until very little remains, especially in the section most likely to suffer from

these bugs, it has become more and more difficult for the quail to survive winters during which there is much drifting snow, and every few years they are snowed or drifted under to such an extent as to be almost exterminated, so that even were there none shot for a period of ten years, it is a question if they would become extremely abundant. At present, the gun clubs and similar organizations of the cities really offer about the only protection that the quail enjoys. This is poor comfort, but until a protective law can be enforced it will be better as it is. That is, it will be of more benefit to both quails and farmers to have a law that will be enforced, even through selfish motives, for six weeks of the year, than to have another, even though a better, that is transgressed the year round, and offers no other than the protection by individual farmers.

Lady beetles also destroy a few chinch bugs, as also the ground beetles, and I have two or three times found "hair snakes," Mermis, in the bodies of these bugs showing that they are attacked by these worms. But, taken altogether, there seems little help for the Ohio farmer, so far as these natural enemies are concerned.

There is one other, the Chinch Bug Fungus, *Sporotrichum globuliferum*, which clearly does exert an influence in reducing an abnormal development in point of numbers, under certain meteorological conditions, and from which I think the farmer secures some benefit, even when the fungus is following its natural course unaided, but as this is being produced and applied artificially, I shall leave the discussion of the matter for the present, to be considered farther under the head of remedies.

REMEDIAL AND PREVENTIVE MEASURES.

With millions of bugs in his field or swarming from out of an adjoining field, either of his own or his neighbors, what is a farmer to do? Usually it is not until the former condition prevails that the farmer becomes aware that there is a chinch bug within miles of his field, and after having learned of their immediate presence, he almost invariably waits to see what they are going to do, and by the time he finds out, they have become diffused over so large an area as to make any effort to control them rather a stupendous affair. If, then, the bugs were gathering on the outer row of corn, as in all cases which I observed in Ohio this year they left the wheat fields for the corn as soon as the grain was harvested, I should follow the directions given in a circular letter, June 24, 1895, by Prof. S. A. Forbes, State Entomologist of Illinois, which is as follows:

"Dissolve one-half pound hard or soft soap in one gallon of water, and heat to the boiling point. Remove from stove and add two gallons of coal oil, churning the mixture with a good force pump for fifteen minutes. When the emulsion is formed, it will look like buttermilk."

"To each quart of this emulsion add fifteen quarts of water, and apply to the corn in a spray—preferably before 10 A. M. or after 3 P. M. The bugs should be washed off so that they will float in the emulsion at the base of the plant. A teacupfull to a hill is generally sufficient, but the quantity must vary with the number of bugs infesting the corn."

That the above is effective and of practical value, I know from personal experience, and I saw many fields last summer in central Ohio, that could have been thus protected, if the effort had been made to do so and at the proper time.

If the bugs had taken possession of more than one of the outer rows of corn, I would put in the plow and turn under a strip along the edge where the bugs were congregated, promptly harrow it down smooth and roll, or pack the surface of the ground with a clod crusher. Bury a chinch bug under three or four inches of soil and it will not crawl out, as I have learned by actual experiment in the field. This applies to corn, but I know of no way of treating the pest in the wheat-fields or meadows. I once tried to use the emulsion among wheat, drenching the small patches of whitening straw when these first began to show in the field, but could not see that any good resulted from the application.

In regard to the fungus, I do not look upon it as a remedial measure at all, but as a preventive one. It is absolutely ineffective during dry weather, unfortunately when it is most needed, and will be found to work but slowly except under the most favorable conditions, besides requiring considerable time to get it sufficiently well established and diffused among the bugs. I therefor place it among the preventive measures, to be discussed further on.

So far as remedies are concerned, then, I can only recommend the use of kerosene emulsion, and in more serious cases the plowing of the infested area followed by harrowing and rolling. In case a migration is in progress from a wheatfield to a cornfield, if about three deep furrows are plowed as closely side by side as possible, the invasion may be stopped. A few bugs will get in and climb out of the first furrow, but less will succeed in passing the second, while the third will stop about all of these. If there are so many that they seem to be escaping after a few days, fill up the trenches with a plank clod crusher or scraper, level off and roll, making new furrows where the ridges were between the old furrows, and you have a new series of obstructions.

If the outer rows of corn are grown up with Foxtail or Panic grass, the bugs will largely remain on that in preference to going farther, or if a strip of millet be sown along the margin between the two fields, so as to have it up several inches by the last of June, or about harvest, this will cause a halt in the migrating hordes, and keep them engaged in feeding

on the growing millet until the food supply begins to fail, when they will move onward. If about this time the farmer will put in his plow and turn under bugs, grass and all and harrow and roll the ground, he will leave so few bugs above ground that they will cause little if any injury. I have tried this where the strip of millet was displaced by fox-tail and panic grass, and know that it will work effectually.

In 1883, in Northern Indiana, a field of wheat was badly infested with chinch bugs, and at harvest time I fully expected a migration to an adjoining cornfield. But the wheat was thin on the ground and badly grown up with grasses, and when the grain was cut, the bugs, instead of migrating, turned their attention to the grass and did not leave it until fully developed, when they took wing and scattered over the country, or at least did no damage. Whether or not plats of millet, sown in spring, would entice the female bugs to go there and deposit their eggs, instead of in the wheat and cornfields, I do not know, but am rather inclined to think some such an effect might be expected, and if so, the destruction of myriads of young would be a simple matter. It would also facilitate the establishing of points of infection by the fungus disease, long before this would be possible in the ordinary manner. Some experiments ought to be made in this direction, but such can only be carried out to advantage in regions infected with the bugs, and therefore are impracticable at the Experiment Station. They can only be made by the farmers themselves.

Where neither of the foregoing measures is practicable, and a prompt defense is necessary, a barrier of tarred boards may be used. Prof. Forbes suggests a mixture of 9 parts coal-tar and 1 part linseed oil, thoroughly mixed and spread upon boards either laid flat on the ground, or placed on edge and the upper edge daubed with the mixture. Where the line of defense is not too long, and one has the boards at hand, this may serve to hold the bugs in check for a time, but if one is obliged to purchase the lumber, the expense will be a serious objection. In some cases a ridge has been thrown up and made smooth and compact on top, the tar mixture being applied in a train with a watering pot without the sprinkling attachment. The trouble here is that the wind blows the dust over this train of oil and tar, soon crusting over the surface so that the bugs crawl over it without sticking fast. For my own part, I am sure that if taken in time the application of kerosene emulsion will stop an invasion in a cornfield, while if ground over which the bugs are passing is plowed and the vegetation thoroughly covered, so that the bugs may not, by following the grass and weeds, make their way easily to the surface, the more serious invasions may be overcome. It is not necessary to destroy every individual bug, and if the number has been reduced so as to ward off material injury, then the end has been accomplished.

In the matter of preventives, I have already indicated the value of destroying all grass, weeds and rubbish, either in the fall or during winter. Prof. Bruner has shown that one very important hibernating place is along hedge fences, where the leaves and grass are combined into a perfect blanket, and there are miles upon miles of roadside as well as division fences other than hedges in Ohio, along each side of which is a wilderness of grass and weeds mingled with underbrush, that is capable of harboring enough chinch bugs to stock the whole State the following year. Not alone the fields lying contiguous to these places are menaced, but many others There seems no good reason for doubting that a chinch bug will find its way to a field of wheat as readily as a robin to a cherry tree in July. Now these hedges and fence rows ought to be cleared up and burned over at a time when the vegetation will burn to the ground, and not leave a covering over the surface, and this should be done annually, and not once in eight or ten years more or less, as the owner happens to be frightened over an outbreak of chinch bugs. This will apply also to any other similar rubbish or waste fodder, straw or hay scattered about the fields.

Now as to the fungus disease, *Sporotrichum globuliferum*, which, though primarily a natural check, is best treated under the head of preventives, as it is in that sense that its use, artificially, is more generally understood, my experience with it in Ohio, last year, has but strengthened the position that I was compelled to take by the results of similar experiments carried out in Indiana several years ago, viz.: that these fungus diseases, in order to work sufficiently, rapidly and effectually to benefit the farmer, require peculiar meteorological conditions and a superabundance of insects at the same time. The fungus does not attack the chinch bug alone, but other insects also, and the fatality of its attack is due to the extent to which the bugs mass together. I have found it to kill the common black blister beetle, *Epicauta pennsylvanica*, as effectually as chinch bugs, when the beetles are confined with diseased bugs. The reason for this increase of fatality, in proportion as the insects are massed together, can best be explained by the illustrations: This fungus is a parasitic plant that pushes its way into the body of insects and destroys them, at the same time living upon the tissue. The external or outside growth of the plant consists of threadlike branches, bearing spores, or seeds as they are called among the higher plants. It would require about 10,000 of these spores, placed side by side, to cover a line an inch long. Now, if one or more of these spores happen to get on the body of a chinch bug, it will send shoots into the body as shown in Fig. 4, Plate I, of the horizontal line representing the surface of the body of the bug. If we plant seeds on the surface of the ground, when it is damp, the seeds will sprout and send roots

downward from the surface, but if the surface is dry no sprouts will appear and none will be sent downward, and this is precisely the case with the fungus in case the weather is dry—the spores will not take effect in the body of the chinch bug unless the weather is damp, or the bug is in a damp locality.

With favorable meteorological conditions, the threadlike branches of the fungus will take possession of the interior of the bug as shown in Fig. 3, which may be supposed to represent a parallel section of Fig. 6, both enlarged figures of an adult chinch bug. When the bug dies, branches are pushed out through the body and produce clusters of minute capsules filled with spores, as shown in Fig. 5, the horizontal line here representing the surface of the body of the dead bug. Sometimes these clusters are so thick on the dead bugs as to almost obscure the body, as shown in Fig. 7, where only the legs are visible, or they may be clustered on a plant, dead and covered with fungus as shown at the left in Fig. 6. Now, as these capsules containing the spores burst, they scatter the spores and these may be still further diffused by the wind, so that it is easy to see how one diseased bug among a mass of several hundred may affect the whole of them, and if some of the infected ones, before becoming helpless, stray to a distance, the infection is carried from place to place and in this way diffused from field to field. Thus it will be observed that however easily large masses of bugs may be destroyed by this fungus enemy, under favorable conditions, if they are badly scattered or the weather is dry, either one, the prospect of its working is not very encouraging. This is simply Nature's way of preventing extermination by an overproduction, for under the most favorable conditions all will not be attacked and killed. In proof of this, I placed a lot of infected dead bugs about some growing wheat in the insectary and then turned a lot of healthy ones loose among the wheat. For a while the living bugs died off from the effects of the fungus, but this gradually ceased, and at present writing, March 4, quite a number are inhabiting the wheat, seemingly in a healthy condition, thus showing that total extermination by this means, even under the most favorable conditions is not to be looked for. Not only are the very young killed by this vegetable enemy, but Prof. Forbes has found that it will destroy the eggs also.

On the whole, our results with this fungus were unsatisfactory, which, considering the prolonged drouth, was only what we could naturally expect. In a few cases I found that the infection had spread from the material sent out, while in other cases farmers sent us diseased dead bugs that they had found sparingly in the fields where the infected bugs had been used, while in still other cases, where farmers sent us bugs collected in their fields a considerable time after receiving and distributing the

material from us, these would be dying from the fungus when received. By this I feel assured that where the weather was at all favorable the fungus became established, but I do not believe that it anywhere destroyed any great number of bugs. Whether it will survive the winter and begin to attack the chinch bugs in season to prevent another outbreak another year, it is too early as yet to predict, though I hope this will prove to be the case.

This same fungus disease, or one very similar, is recorded by my predecessor, Mr. Weed, as following the outbreak of 1887 and 1888, (see 7th annual report of this Station, pp. 164–67), and in two or three instances I feel quite sure that it appeared naturally last year, as it was reported, in one case accompanied by specimens, where it could hardly have spread from infected material sent out by the Station. If this was the case, we have additional grounds for expecting aid another season, in case it is needed and the conditions are favorable for the development and spread of the fungus.

I did not attempt to secure from farmers any written statements as to their observations on the effects of the fungus, because I have long doubted the value of such information. When about to cast its skin for the last time the chinch bug appears to understand its helpless condition during the ordeal, and for this reason crawls to some secluded place, notably under the sheaths of corn and similar places, and from which, after casting their skins they emerge and scatter over the fields. These cast skins, to the unentomological farmer, have every appearance of dead bugs and especially if, as is often the case, these become covered with the ordinary white mold, thus giving a very deceptive resemblance to chinch bugs attacked by the deadly fungus. I have had several very surprising statements come to me regarding the effect of the chinch bug fungus, based on such material, and have refrained from sending out circulars of inquiry among those to whom we distributed material, about 700 in number, feeling sure that however honestly the replies were made, little reliance could be placed upon them unless accompanied by specimens. I think this season's experience has still further emphasized the inefficacy of this measure during drouth, the very time, unfortunately, when it is most needed. What the future may reveal I do not know, but at present the foregoing seems to be the true condition of the problem of fighting the chinch bug with fungus.

SUMMARY.

The chinch bug extends over the most of the United States east of the Rocky Mountains. It is double brooded, the insect passing the winter in the adult stage, very largely at least, and depositing eggs for the first brood of young during May and June, these young becoming full grown and depositing eggs in July and August, according to locality, and the young from these eggs developing and passing the winter as previously stated.

Each female deposits about 500 eggs, usually placing them about the surface of the ground on stems of grass, grains and in rare cases other plants. The young are at first of a red color, later changing to brown-black, while the adult is black with white wings. The wings are not obtained until full development has been reached, and, hence, in the most destructive period the insects crawl instead of fly, and the true cause of injury is less on account of numbers than of the habit of clustering in myriads on the plant attacked.

A heavy fall of rain during the hatching season is fatal to the very young chinch bugs, and it is probably this character that prevents their becoming more abundant and destructive, though probably the fungus parasite would also contribute to hold the species in check, especially during seasons of reasonable rainfall.

The chinch bug is provided with a sucking and not a biting mouth and therefore cannot be poisoned. Kerosene emulsion, made and applied as recommended in the text will be found effective; ditching in front of their advance, and plowing, harrowing and rolling the ground will bury and destroy large numbers. The fungus can be used to advantage when the weather is favorable, especially on fields that are inclined to be damp. The burning of old grass, leaves and rubbish in winter will destroy many hibernating adults and reduce the numbers the following year.

EXPLANATION OF PLATE.

Fig. 1. Adult chinch bug, *Blissus leucopterus*, enlarged; the line below indicating natural length. After Riley.

Fig. 2. The earlier stages of development; *a* and *b*, eggs, enlarged with natural size at right; *c*, newly hatched larva; (lines at right of figures indicate natural size) *d*, tarsus or foot; *e*, larva or young after first molt; *f*, same, after second molt; *g*, pupa; *h*, enlarged leg of adult bug; *j*, foot of same still more enlarged; *i*, beak of same still more enlarged showing the sucking mouth. After Riley.

Fig. 3. Enlarged profile of bug showing the growth of the fungus, *Sporotrichum globuliferum*, both internally and externally. After Snow.

Fig. 4. Fungus spores pushing their shoots or roots downward into the body of the bug, the horizontal line indicating surface of body. After Snow.

Fig. 5. Showing fungus pushing its way upward through the surface of the body and producing spores. After Snow.

Fig. 6. Enlarged view of chinch bug affected by fungus, with clusters of dead on plant at left, natural size. After Riley.

Fig. 7. Chinch bug attacked and covered with the fungus, showing only the legs of deceased bug. After Forbes.

The base for map, on which distribution of chinch bug in North and Central America is indicated, was kindly furnished me by Dr. C. Hart Merriam, of the United States Department of Agriculture.

Fig. 1.

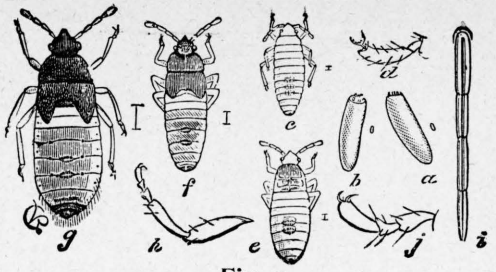

Fig. 2.

Fig. 4.

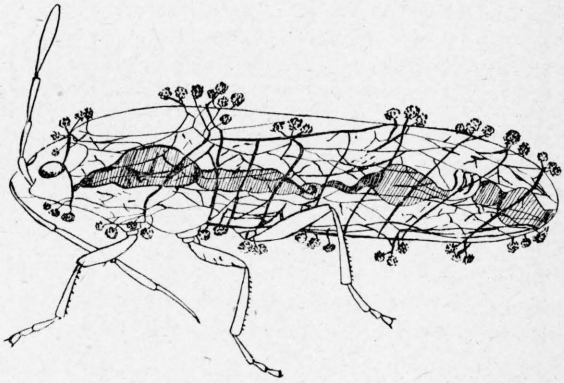

Fig. 3.

Fig. 6.

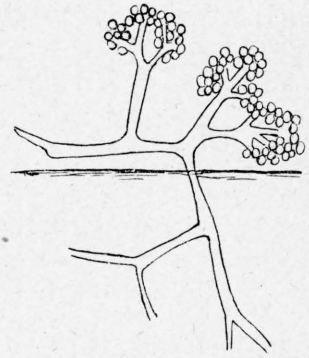

Fig. 5.

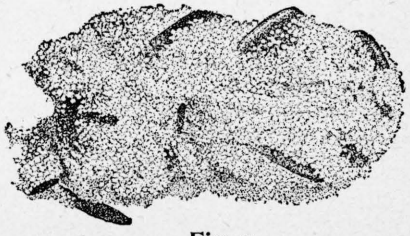

Fig. 7.

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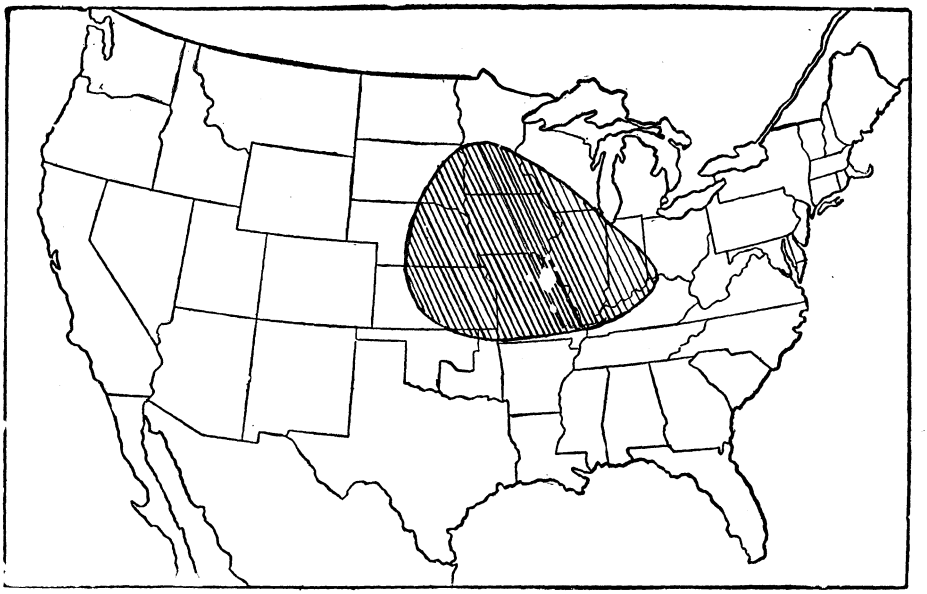
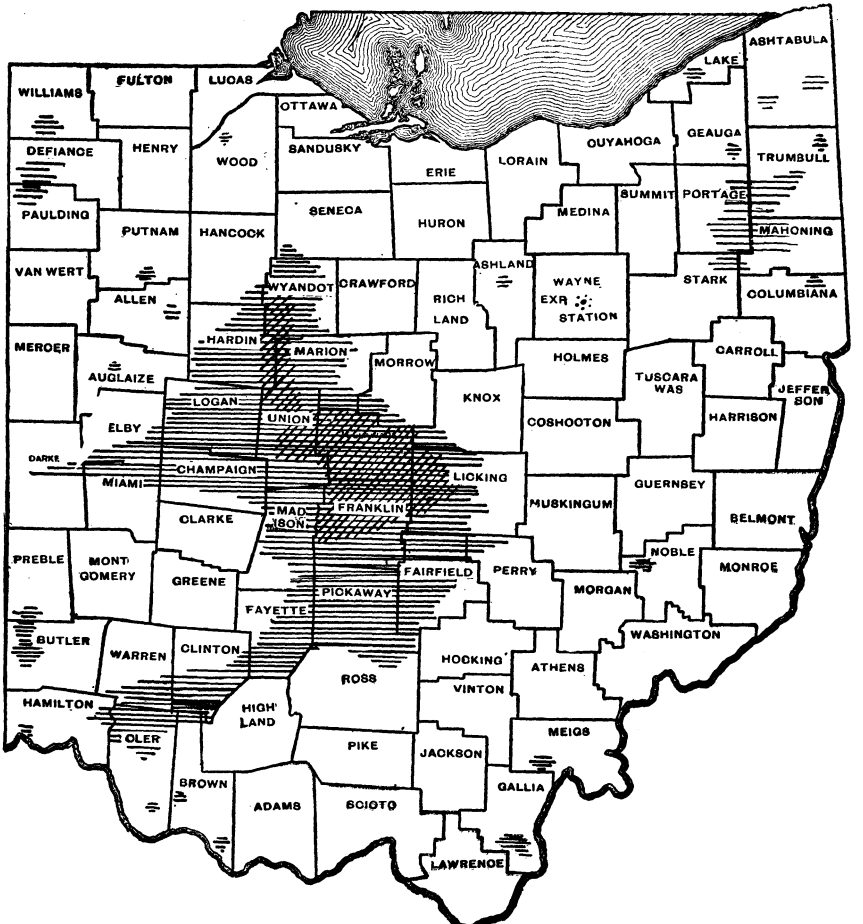


FIG. 1. Showing approximate area most ravaged by Chinch Bugs.



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Blissus leucopterus.
Distribution
in
Cent.& N. America.

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